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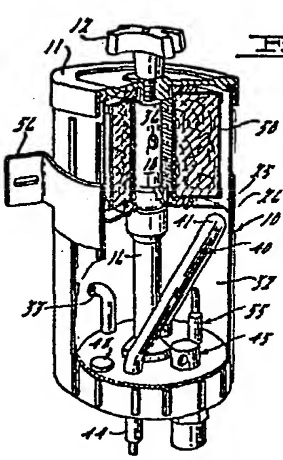
(54) Drain system for fuel processor apparatus.

(57) A drain system adapted for use in fuel processing devices, as well as in other fluid equipment applications, includes sensing means for detecting the presence of a predetermined quantity of water or other impurities separated from the fuel, or the presence of other fluids, in an enclosure or container. Drain means are also included for discharging at least a substantial portion of the predetermined quantity in response to said detection of the presence thereof. The drain means is preferably actuated and deactuation by automatic control means in order to maintain said water or other impurities, or said other fluids, at or below the predetermined quantity. The fuel processing device herein further includes means for heating fuel in order to prevent fuel waxing and clouding. Several embodiments are described which are particularly useful for treating fuel as it is transmitted to an engine or other consuming device whereas another embodiment describes a fuel processing device particularly adapted for treating fuel as it is drawn from and returned to the fuel tank.

FIG. 1.



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DRAIN SYSTEM FOR FUEL PROCESSOR APPARATUS

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates generally to automatic drain systems and more particularly to such drain systems for fuel processing apparatus for diesel and other types of engines.

In the past, when diesel fuel and other hydrocarbon fuels were plentiful and relatively inexpensive, there were significantly fewer problems with the quality of the fuel because of the substantial competition between sellers of the fuel. Refineries, distributors, and retailers were careful to keep water out of the fuel, and they usually did not pump out the heavy settlings and water from the bottom of the fuel storage tanks. In more recent times, however, because of shortages of oil and other factors, fuel suppliers can readily sell essentially all of their available oil with little difficulty. Also, in the past, kerosene and other fuels with lower cloud and pour points were blended with diesel fuel to facilitate cold weather flow and use. Fuel allocations due to government regulations, oil shortages, and other factors have now made it almost impossible to continue this practice. The result of these developments has been a distinct tendency toward lower quality fuel containing substantially more impurities, such as water, waxes, heavier compounds and particulate materials, which are very disruptive to the proper operation and starting of a diesel engine. Thus, one important object of this invention is to provide a new and improved fuel processor apparatus particularly for diesel trucks and other diesel-powered automotive vehicles to remove water and other impurities from the diesel

fuel and to provide improved means for draining the water or ther impurities from the processor apparatus.

An improved fuel processor apparatus broadly includes a fluid-tight chamber or canister through which the fuel flows and in which water and other impurities are separated in a lower portion of the chamber or cannister. In accordance with the invention, a sensing apparatus is located in the lower portion of the chamber for detecting the presence of a predetermined quantity of water or other impurities, and a drain device is actuable, either manually or preferably automatically, in response to detection of said predetermined quantity to discharge at least a substantial portion of the water or other impurities in order to maintain them at or below said predetermined quantity. In a preferred form of the invention, automatic control means is provided for automatically actuating the drain device in response to detection of said predetermined quantity and for automatically deactuating the drain device in response to detection of a second lower quantity of such water or other impurities. In such preferred form of the invention, the quantity of water or other impurities is maintained generally between said predetermined and second quantities in order to substantially ensure that fuel is not discharged when the drain device is actuated.

This invention contemplates fuel processing systems which are located within an engine supply circuit and further systems which are employed to draw fuel from a tank and recirculate it to the tank after processing.

Additional objects, advantages and features of the present invention will become apparent from the following description and the appended claims, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view f a fu l processing device constructed in accordance with the present invention, partially broken away.

Figure 2 is a vertical diametric sectional view of the fuel processing device of Figure 1.

Figure 3 is a schematic representation of one optional embodiment of an automatic drain system in accordance with the present invention.

Figure 4 is a schematic representation of another optional embodiment of an automatic drain system in accordance with the present invention.

Figure 5 is a schematic representation of still another optional embodiment of an automatic drain system in accordance with the present invention.

Figure 6 is a schematic view of another optional embodiment of a fuel processor according to this invention most preferably employed within a fuel processing system which draws fuel from the fuel tank and thereafter returns it to the tank.

Figure 7 is a cross sectional view taken along line 7-7 of Figure 6 particularly illustrating the internal components within the fuel processor cylindrical enclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

For purposes of illustration, Figures 1 through 5 of the drawings illustrate exemplary embodiments of the present invention as incorporated into a diesel fuel processing apparatus having an electric heating element and an integral filter section with a filter cartridge therein. One skilled in the art will readily recognize from the following discussion that the principles of the invention are equally applicable to other types of fluid separator devices as well as to other types of fuel processing

apparatus ther than that shown in the drawings, including the fuel processing devices disclosed in U.S. Patent No. 4,368,716, issued January 18, 1983, and copending application, serial no. 287,149, filed July 27, 1981, both of which are assigned to the same assignee as the assignee herein. The disclosures of said patent and said copending application are incorporated by reference herein. The embodiments shown by Figures 1 through 5 are most preferably employed within the fuel supply circuit of the motor vehicle engine. In this manner, fuel is treated as it is drawn by the engine fuel supply system.

Reference character 10 designates generally a fluid-tight open-topped cylindrical enclosure or chamber to which a gasketed fluid-tight cover 11 is removably and clampingly secured by means of a wing nut 12. A two-part tubular support and conduit assembly designated generally at 15 is positioned axially in the chamber 10 and has a bottom section 16 rigidly and threadably secured in, and upstanding from, a suitably tapped opening 17 in the bottom wall 23 of the chamber 10. The support and conduit assembly 15 has an upper section 18 rigidly and threadably attached to the lower section 16. The interiors of the tubular sections 16 and 18 communicate to define an axial passage 20 which communicates with the exterior of the chamber 10 through a fitting 22 to which a fuel outlet conduit (not shown) is adapted to be sealingly attached. The threadably interfitted male and female portions 24 and 24a, respectively, of the upper and lower sections 18 and 16 serve as means for rigidly supporting a combined baffle and filter supporting plate 25 clamped therebetween. Supporting plate 25 is of a diameter slightly less than the inside diameter of the canister or chamber, thereby providing a relatively narrow annular slot 26 for a purpose described below. The upper end of the tubular section 18 is tapped to threadably receive a stud 14 for attachment to the wing nut 12 and to provide a firm support for attachment of the cover 11.

A fuel inlet fitting 30 attached to, and extending through the bottom wall 23 of the chamber 10 is adapted to deliver fuel to the lower chamber portion 32 below the supporting plate 25. An inlet pipe 33 connected to the fitting 30 extends upwardly within the chamber 32 and has an outlet generally tangential to the inside wall of the chamber to impart a rotary motion to the fuel therein.

The fuel flows upwardly from the lower chamber portion 32 through the gap or slot 26 into the upper chamber portion 35 above the supporting plate 25. After passing inwardly through a filter element 50, the fuel enters the upper passage portion 21 in the upper support tube section 18, by way of radially-extending holes 36, and is then conveyed downwardly through passage 20, out through the fuel discharge fitting 22, and to the fuel inlet of the engine.

An electric heating element 40 is provided in the lower chamber portion 32 and is bent to an inverted U-shaped form, having its lower ends in communication with electrical connections 42 and 44 being supported in the bottom wall 23 of the chamber. It should be noted that the upper end of the heating element 40 extends to a position close to the gap 26 through which the fuel flows to the upper chamber portion 35, which contains the filter 50. If a different type of heating unit is employed, such as the fluid-conveying tubular heater shown in the above-mentioned U.S. Patent No. 4,368,716 and in the copending application, serial no. 287,419, it also projects upwardly from the bottom wall to a position close to the gap 26 so that its upper portion is positioned comparably to the bight portion 41 of the heating element 40. Such a heater, as well as other types of heaters known in the art, may be substituted for the heating element 40 shown in the drawings herein for purposes of illustration.

As is best shown in Figure 2, the bight portion 41 of the heater element 40 is slightly spaced from both the supportable plate 25 and the inner wall f the chamber 10. Thus when the ignition system of the

vehicle is energized, the heating element is also energized and warmed v ry quickly, and consequently the fuel close to the heating element is also warmed very quickly. This is important in cold weather, because wax crystals which have formed in the cold fuel tend to readily clog the filter element 50. When the heating element 40 is initially energized, there is insufficient heat build-up to heat all of the fuel adequately to melt wax or ice crystals, but only a small amount of heat is needed to melt such cyrstals in a small region of the gap 26 and the lower edge of the side of the filter 50 that is adjacent the bight portion 41 of the heating element. With this heating element construction, the portion of the fuel flowing through the gap 26 at a position close to the bight portion 41 of the heating element is sufficiently heated quickly enough to maintain a clear, wax-free path or "window" through the filter 50 until the fuel processing apparatus, and the engine itself, can reach normal, steady state operating temperatures. When the fuel in the entire lower chamber portion 32 is warmed, it of course freely flows upwardly through the entire annular gap.

The bottom wall 23 of the chamber 10 also supports a drain valve means, indicated generally by reference numeral 45, for discharging water and other impurities that have been separated out into the lower chamber portion 32. Preferably the drain valve means 45 is an electric solenoid-operated valve, as shown in the drawings, but may alternately be operated manually or by pneumatic, hydraulic, or other means known to those skilled in the art. A chamber quantity sensing means, indicated generally by reference numeral 55, is also provided for detecting the presence of various quantities of water or other impurities in the lower chamber portion 32 and for generating a signal in response thereto. The fuel processing apparatus may also optionally, if desired, include a chamber temperature sensing means 48 for detecting and monitering the temperature of the water or other fluids or impurities in the lower

chamber portion 32 and for generating a signal in response to detection of said temperatures below a predetermined value. The function and interaction of the drain valve means and the chamber quantity sensing means, as well as the optional chamber temperature sensing means, are discussed and explained below in connection with the schematic representations of various embodiments of the invention illustrated in Figures 3 through 5.

The filter element or cartridge 50 may be of a known commercially-available cylindrical drop-in type, supported and clamped between the cover and the supporting plate 25 on suitable hub portions 13 and 19 projecting from the cover and from the upper tube section 18, respectively, with suitable gasketing means being provided as indicated at 51 and 52. Alternately, other filters of the drop-in, internal, or spin-on types, as disclosed in the above-mentioned U.S. Patent No. 4,368,716 and in the copending application, serial no. 287,419, for example, may be employed.

The fuel processing unit is adapted to be mounted in a suitable location by means of a bracket 56 at a position where the upper portion is readily accessible so that when desired the cover 11 may be removed and the filter element 50 replaced.

Figures 3 through 5 schematically illustrate several exemplary variations of the preferred form of the present invention. In the variation of Figure 3, the lower portion 32 of the chamber 10, which is under a positive pressure, includes a chamber quantity sensing means and a drain valve means. The sensing means preferably comprises a chamber fluid level sensor 60 having an electrical probe 62, a lower portion of which is surrounded by insulating means 64, extending generally upwardly therein. The drain valve means preferably comprises a solenoid-operated valve 70 located at the bottom of the chamber and having at least one inlet 72 and an outlet 74, which are configured such that the valve 70 provides fluid

communication between the interior of the lower chamber portion 32 and the exterior of the chamber 10 when actuated and prevents such fluid communication when deactuated.

The chamber fluid level sensor 60 is adapted to generate distinct signals when the electrical probe 62 is exposed at various points along its vertical length or height to one or more fluids having distinct electrical characteristics, such as electrical conductivity or resistance, for example. The sensor 60 is connected by way of an electrical conductor 61 to an automatic controller 80, and similarly the solenoid-operated valve 70 is connected by way of electrical conductor 63 to the controller 80.

In operation of the Figure 3 variation, water and/or other impurities are separated from the fuel and settle to the bottom of the lower chamber portion 32, thereby creating an interface between the fuel and the water and/or other impurities. Since the fuel and such water and/or impurities typically have different electrical characteristics, the signal generated by the probe 62 changes as the level of such interface moves up and down its vertical length or height. Such signal therefore changes as greater quantities of water and/or other impurities are separated from the fuel in the lower chamber portion 32, ranging from a condition wherein the interface is at a level below the upper end of the insulating means 64 and the probe 62 is exposed only to fuel, to a condition wherein the interface has risen to various intermediate positions on the probe 62 so that the probe is exposed to varying amounts of fuel and water and/or other impurities, and finally to a condition wherein the interface is at or above the upper end of the probe and the probe is exposed only to water/impurities.

The controller 80, which preferably comprises a conventional microprocessor unit or other electronic circuitry known to those skilled in the art, is adapted to receive, and differentiate between, the varying

signals from the sensor 60 as the level of the above-mentioned interface changes. Thus the controller 80 is pre-set, adapted, or programmed to cause the solenoid-operated valve 70 to be actuated at a predetermined high level of such interface between the fuel and the water and/or other impurities, such as at the level 90. The controller 80 is also pre-set, adapted, or programmed such that when the valve 70 is actuated, the water and/or other impurities are discharged through the outlet 74 of the valve 70 until the level of the interface recedes to a predetermined low interface level, such as the level 92, at which time the valve 70 is deactuated and closed. Thus the quantity of water and/or other impurities in the chamber 10 is maintained generally between the predetermined levels 90 and 92. It should be noted that the level 92 should be established so that the interface is above the inlet 72 of the valve 70 in order to avoid dumping or discharging fuel along with the water and/or other impurities.

If desired in the Figure 3 variation, as well as in any of the other variations or embodiments of the invention shown and described herein, the temperature sensing means 48 may optionally be included and connected to the controller 80, such as by way of electrical conductor 65, to override and prevent the controller 80 from causing the valve 70 to discharge the water and/or other impurities if the temperature in the lower chamber portion 32 is below a predetermined temperature level. Such predetermined temperature level should be slightly above the freezing point of the mixture of water and other impurities in order to avoid damage to, or improper operation of, the valve 70 due to frozen solids being introduced therein. Additionally, if desired, the heating element 40 may optionally be connected to a power source (not shown) by way of the controller 80 so that the controller may also be used to regulate the power to the heating element in response to signals from the temperature sensing means 48. It should be noted that the temperature sensing means 48 may comprise a thermostat device, a thermistor, r other such

temperature sensing devices known to those skilled in the art.

The variation of the present invention represented schematically in Figure 4 is substantially similar to that described above in connection with Figure 3, except that the exemplary single-probe chamber fluid level sensor 60 of Figure 3 is replaced by an exemplary dual-probe chamber fluid level sensor 60'. Chamber fluid level sensor 60' includes a pair of electrical probes 68 extending generally upwardly in the lower chamber portion 32 and located closely adjacent to one another. Thus, rather than the single-probe sensor 60 measuring electrical conductivity or resistance, for example, between the single probe and the wall of the chamber 10 or some other electrode therein, the dual-probe sensor 60' measures such electrical quantities between the two probes 68, themselves. Because the probes 68 are located close to each other relative to the distance between the probes and the wall of the chamber, it is believed that the dual-probe sensor 60' is capable of more accurate measurements of the level of the interface between the fuel and the water and/or other impurities. Such increased accuracy is believed to exist especially when the fuel processor apparatus is disposed at an attitude such that the fluids therein are not substantially horizontal, such as when a vehicle having the apparatus thereon is travelling on uneven terrain or is engaged in sharp cornering maneuvers, for example.

The chamber fluid level sensor 60' is adapted to generate distinct signals when the probes 68 are exposed to one or more fluids extending between them at various corresponding levels along their lengths. Thus because the fuel and the water and/or other impurities typically have different electrical characteristics, such as conductivity and resistance between the probes 68, for example, the sensor 60' generates a signal that changes as the level of the interface between the fuel and the water or other impurities moves up and down at various levels on the probes 68. Thus, such signal changes, as is described above in

connection with Figure 3, as greater quantiti s of the water and/or other impuriti s are separated from the fuel in the lower chamber portion 32. As is also described above, the controller 80 is pre-set, adapted, or programmed to receive and differentiate between the varying signals from the sensor 60' in order to actuate the solenoid-operated valve 70 at a predetermined high level of the interface, such as at the level 90, and to deactuate the solenoid-operated valve at a predetermined low level, such as the level 92.

The variation of the present invention which is represented schematically in Figure 5 is substantially similar to those shown and described above in connection with Figures 3 and 4, but is particularly adapted for use in a chamber 10 that is under a negative pressure. Such negative pressure at least inhibits, if not prevents, the water and/or other impurities from being discharged under the force of gravity through the solenoid-operated valve 70, as in the positive-pressure arrangements shown schematically in Figures 3 and 4. Therefore, the solenoid-operated valve 70' in Figure 5 includes a pump means 96 incorporated therein. Thus, when the controller 80 receives a signal from the chamber fluid level sensor 60 or 60', which corresponding to an interface level at the predetermined level 90, the controller 80 causes the solenoid-operated valve 70' and the pump means 96, which is preferably a positive displacement pump, to be activated to forcibly discharge the water or other impurities from the chamber 10. When the interface level reaches the level indicated at 92, the controller 80 causes the solenoid-operated valve 70' and the pump means 96 to be deactuated. Alternately, the controller 80 may be pre-set, adapted, or programmed to actuate the solenoid-operated valve 70' and the pump means 96 only for a predetermined time period after the fluid level sensor senses an interface level at the predetermind high level 90. In still another alternate version of the arrangement shown in Figure 5, such predetermined timed actuation of the

solenoid-operated valve 70' and the pump means 96 may be used in conjunction with the above-described actuation and deactuation in response to interface levels 90 and 92, respectively, and therefore serve as a redundant back-up feature for such normal operation. It should be noted that the arrangement shown schematically in Figure 5 may alternately include either a single-probe sensor as in Figure 3 or a multi-probe sensor as in Figure 4.

It should be emphasized that although the present invention is shown and described herein, for purposes of illustration, as incorporated in a fuel processing apparatus for separating water and/or other impurities from the fuel, the invention is not so limited. One skilled in the art will readily recognize that the invention, as described and illustrated herein, has wide-spread applicability and adaptability in any number of devices or systems in which materials having distinct electrical characteristics are to be monitered and drained from an enclosure or container, for example.

An additional embodiment of a fuel processor apparatus according to this invention is described with reference to Figures 6 and 7. The embodiment described by those Figures is preferably employed in connection with a fuel processor system which draws fuel from the fuel tank, circulates it through the fuel processor, and then returns it to the fuel tank. Such configuration does not require fuel flow to an engine or another fuel consuming device in order to treat the fuel. This system permits fuel in a fuel tank to be treated irrespective of operation of an engine or other fuel consuming device. Thus, fuel may be drawn from the tank, circulated through the fuel processor where it is heated and water is removed and then returned to the fuel tank.

A fuel processor generally referred to by reference character 108 may include a completely enclosed cylindrical vessel 110 forming fluid inlet 112 and fluid outlet 114. Fluid inlet 112 is located near the

vertical center of cylindrical enclosure 110 which is el ngated in a vertical direction. Fluid outlet 114 is located at or near the vertical top of the enclosure 110. This configuration permits water, which has a specific gravity greater than that of the fuel contained within fuel tank 116, to settle to the bottom region of cylindrical enclosure 110, as previously described. Fuel processor cylindrical enclosure 110 is shown without an internal particulate filter, unlike the previously described embodiments. Since fuel circulating through processor 108 is returned to the fuel tank, and not to the engine, such a filter is unnecessary. However, it may be desired in some applications to provide such a filter, and such modification is entirely within the scope of this invention.

Fuel processor 108 is connected to fuel tank 116 via inlet conduit 118 and outlet conduit 120. Within inlet conduit 118 is inline fuel pump 122 which is preferably energized by electrical power. As is evident by reference to Figure 6, fuel is drawn from near the bottom of fuel tank 116, circulated through fuel processor 108 and returned to the fuel tank at a point some distance from the inlet conduit pickup. A fuel tank water sensor 124 provides a signal responsive to water accumulation within the fuel tank. Fuel tank 116 may also include a temperature sensing apparatus 126. As will be subsequently described, fuel tank water sensor 124 will function to energize inline fuel pump 122 when a predetermined quantity of water or other impurity is sensed within fuel tank 116. Temperature sensor 126 within fuel tank 116 may also be employed to energize inline fuel pump 122 when the fuel temperature falls below a desired level.

Fuel processor 108 employs many of the elements previously described in connection with other embodiments of this invention. Cylindrical enclosure bottom 111 forms a mounting location for a solenoid operated water valve 70, having an inlet 72 and an outlet 74 acting to controllably permit the discharge of r retention of fluid within

cylindrical enclosure 110. In the event that inline fuel pump 122 is connected to outlet conduit 120, causing a negative fluidic pressure within enclosure 110, it will be necessary to replace solenoid operated water valve 70 with a pump means 96, as previously described. Heating element 40 is also installed within cylindrical enclosure 110. As previously described, such a heating element may comprise an electrical resistance-type heating element or a number of other types. Temperature sensing means 48 is further incorporated within the cylindrical enclosure 110, and preferably located in enclosure bottom 111.

This embodiment of the invention further features a modified system for sensing the presence of water within fluid contained by cylindrical enclosure 110. Rather than employing vertically elongated probes such as indicated by reference character 62 in Figure 3, and reference character 68 in Figure 4, this embodiment features a pair of substantially flat probes 128 and 130 installed within the side surface of enclosure 110 which are both installed at an equal vertical height. Probes 128 and 130, like probes 62 and 68, provide a signal responsive to the differing electrical characteristics of fuel and water or impurities and are insulated electrically from enclosure 110 by insulators 148 and 150 in the event that the enclosure is formed from an electrically conductive material. Preferably, a pair of such probes are located directly opposing one another and oriented such that they face the fore and aft directions of the associated motor vehicle. Such configuration permits the water sensing mechanism to compensate for the affects of vehicle acceleration and deceleration which causes the interface surface between retained water and fuel within the processor to become inclined. These effects may be compensated for by requiring that both probes 128 and 130 detect the presence of impurities before valve 70 is caused to discharge fluid. Further, the effects of transient changes in the fluid within enclosure 110 may be minimized by requiring that the probes sense

the presence of impurities for at least a minimum period of time, for example five seconds. The means for detecting the presence of impurities within enclosure 110 including probes 128 and 130 is equally useful if used in connection with the embodiment of the invention previously described and such use is entirely within the scope of this invention.

Probes 128 and 130, unlike the earlier described probes 62 and 68, are not capable of providing signals responsive to several predetermined quantities of water retained within enclosure 110, therefore means are provided to cause a desired quantity of fluid to be discharged from solenoid operated water valve 70 in the event that water is detected as is described below in connection with the operation of the system.

Controller 80, preferably of integrated circuit-type, operates to perform two distinct functions when used in connection with the embodiment shown by Figures 6 and 7. A pair of electrical conductors 132 and 134 transmit signals between controller 80 and fuel tank water sensor 124 and fuel tank temperature sensor 126. Signals generated by these fuel tank mounted sensors are employed by the controller to selectively energize and de-energize inline fuel pump 122. Thus, when a predetermined level of water or other impurities is sensed within fuel tank 116, inline fuel pump 122 is caused to energize and circulate fuel through fuel processor 108. Inline fuel pump 122 may also be caused to energize when tank temperature sensor 126 detects a fuel temperature below a predetermined level, and would be caused to de-energize once the fuel temperature is warmed sufficiently by fuel processor 108.

Controller 80 also functions to monitor the conditions within fuel processor 108 to selectively cause solenoid operated water valve 70 to allow material accumulating within cylindrical enclosure 110 to be dumped or retained as desired. Sensors 128 and 130 are connected to controller 80 by conductors 136 and 138 respectively. Similarly, valve 70 is connected to the controller by conductor 140. Thus, when a pre-

determined level of water or other impurity forms within cylindrical enclosure 110 and the temperatur is above a predetermined level, solenoid operated valve 70 is caused to drain impurities from within the cylindrical enclosure until the impurity level reaches a second predetermined level, at which time solenoid operated valve 70 is caused to block the flow of material out of the cylindrical enclosure. As earlier described, probes 128 and 130 are capable of detecting only one predetermined quantity of water retained within enclosure 110. This predetermined quantity which probes 128 and 130 respond to is a function of their vertical positioning within enclosure 110. This predetermined level occurs as the interface between fuel and water in the enclosure is at the position indicated by line 146 whereupon the interface reaches both sensors 128 and 130. Since operating solenoid operated water valve 70 only when both probes 128 and 130 are exposed to the impurities would result in undesirable rapid cycling, other means of controlling the valve are preferred. For example, once impurities are detected by the probes, valve 70 could be caused by controller 80 to open for a predetermined duration, calculated to cause the expulsion of a desired portion of the fluid existing below the level at which probes 128 and 130 are placed. The quantity of fluid which would be expelled over a given time duration can be estimated by opening the valve only when pump 122 is operated. In such conditions, it could be assumed that all of the fluid pumped by the pump is displacing fluid within enclosure 110 which is being dumped by valve 70. This assumption can be made since the fluid flow path of resistance is much less restrictive through valve 70 as compared with outlet conduit 120, and therefore, when the valve is opened the fluid flow through the outlet conduit becomes negligible.

Controller 80 may also be employed to monitor the temperature of fluid within enclosure 110. By receiving a temperature signal supplied by sensor 48 via conductor 142, the electrical power provided to heater 40

through conductor 144 can be modulated. In addition, a temperature signal may be used to prevent the pening of valve 70 when ice has formed in the enclosure, thereby preventing damage to the valve.

The foregoing discussion discloses and describes exemplary embodiments and variations of the present invention. One skilled in the art will readily recognize from such discussion that various changes, modifications and other variations may be made therein without departing from the spirit and scope of the invention as defined in the following claims.

CLAIMS

1. In a fuel processor operative to separate out water or other impurities from fuel, the fuel processor including a chamber adapted to receive the fuel flowing therethrough, the water in the fuel or other impurities being separated into a lower portion of the chamber, the improvement comprising:

chamber quantity sensing means located in the chamber for detecting the presence of at least one predetermined quantity of water or other impurities therein said chamber quantity sensing means including at least one electrical contact disposed within the side surface of the chamber;

drain means actuatable to at least a portion of the water or other impurities from the chamber in response to the detection of said predetermined quantity of water or impurities by said chamber quantity sensing means; and

control means for causing actuation of said drain means in response to the detection of said predetermined quantity or other impurity in the chamber.

whereby the quantity of said water or other impurities in the chamber is maintained at or below said predetermined quantity.

2. The improved fuel processor according to Claim 1 wherein a first and second sensing means are provided located at opposing sides of the chamber.

3. The improved fuel processor according to Claim 2 wherein the fuel processor is adapted for use on a motor vehicle and wherein said first and second sensing means are oriented in the fore and aft directions of the motor vehicle.

4. The improved fuel processor according to Claim 2 wherein said control means causes actuation of said drain means only when both said first and second sensing means detect the presence of water or other impurities in the chamber.

5. The improved fuel processor according to Claim 3 wherein said control means causes actuation of said drain means only when both said first and second sensing means detect the presence of water or other impurity in the chamber for at least a first preselected time period.

6. The improved fuel processor according to Claim 1 wherein said control system causes deactuation of said drain means after a second preselected time period has elapsed.

7. The improved fuel processor according to Claim 1 wherein the fuel processor further includes temperature sensing means.

8. The improved fuel processor according to Claim 7 wherein said temperature sensing means providing a signal to said control means, said control means preventing actuation of said drain means when the temperature sensed by said temperature sensing means is below a predetermined temperature.

9. The improved fuel processor according to Claim 8 wherein the improvement further comprises heater means disposed within the chamber.

10. The improved fuel processor according to Claim 9 wherein said control means modulates the heating effect provided by said heating means in response to said signal provided by said temperature sensing means.

11. The improved fuel processor according to Claim 9 wherein said heater means comprises an electrical resistance heater.

12. In a fuel processor operative to separate out water or other impurities from the fuel, the fuel processor interconnected to a fuel circuit wherein the fuel is pumped from a fuel tank, circulated within the fuel processor and returned to the fuel tank, the fuel processor including a chamber adapted to receive the fuel flowing therethrough, the water in the fuel or other impurities being separated into a lower portion of the chamber, the improvement comprising:

chamber quantity sensing means located in the chamber for detecting the presence of at least one predetermined quantity of water or other impurities therein; and

drain means actuatable to discharge a substantial portion of the water or other impurities from the chamber in response to the detection of said predetermined quantity of water or impurities by said chamber quantity sensing means;

whereby the quantity of said water or other impurities in the chamber is maintained at or below said predetermined quantity.

13. The improved fuel processor according to Claim 12 wherein said chamber quantity sensing means comprises at least one electrical contact disposed within the side surface of the chamber, said improvement further comprising control means for causing actuation of said drain means in response to the detection of said predetermined quantity or other impurity in the chamber.

14. The improved fuel processor according to Claim 13 wherein a first and second sensing means are provided located at opposing sides of the chamber.

15. The improved fuel processor according to Claim 14 wherein the fuel processor is adapted for use on a motor vehicle and wherein said first and second sensing means are oriented in the fore and aft directions of the motor vehicle.

16. The improved fuel processor according to Claim 14 wherein said control means causes actuation of said drain means only when both said first and second sensing means detect the presence of water or other impurities in the chamber.

17. The improved fuel processor according to Claim 14 wherein said control means causes actuation of said drain means only when both said first and second sensing means detect the presence of water or other impurity in the chamber for at least a first preselected time period.

18. The improved fuel processor according to Claim 13 wherein said control system causes deactuation of said drain means after a second preselected time period has elapsed.

19. The improved fuel processor according to Claim 12 wherein the fuel processor further includes temperature sensing means.

20. The improved fuel processor according to Claim 19 wherein said temperature sensing means providing a signal to said control means, said control means preventing actuation of said drain means when the

temperature sensed by said temperature sensing means is below a predetermined temperature.

21. The improved fuel processor according to Claim 20 wherein the improvement further comprises heater means disposed within the chamber.

22. The improved fuel processor according to Claim 21 wherein said control means modulates the heating effect provided by said heating means in response to said signal provided by said temperature sensing means.

23. The improved fuel processor according to Claim 21 wherein said heater means comprises an electrical resistance heater.

24. The improved fuel processor according to claim 12, wherein said chamber quantity sensing means is also adapted to detect the presence of a second quantity of said water or other impurities within said chamber, said improvement further including control means for causing actuation of said drain means in response to the detection of said predetermined quantity of water or other impurities in the chamber and for causing deactuation of said drain means in response to detection of said second quantity of water or other impurities in the chamber, said predetermined quantity being greater than said second quantity, whereby the quantity of said water or other impurities is maintained generally between said predetermined quantity and second quantity.

25. The improved fuel processor according to claim 24, wherein said drain means is actuated and deactuated automatically by said control means in response to the detection of said respective

predetermined and second quantities of water or other impurities within the chamber, whereby the quantity of water or other impurities is automatically maintained generally between said predetermined quantity and said second quantity even when the fuel processor is unattended.

26. The improved fuel processor according to claim 12, wherein said chamber quantity sensing means includes chamber probe means protuding in a generally vertical direction into the lower portion of said chamber, said chamber probe means being adapted for detecting the presence of a predetermined level of said water or other impurities therein generally corresponding to said predetermined quantity and for generating a first signal to indicate the presence of said predetermined quantity.

27. The improved fuel processor according to claim 26, further comprising automatic control means for receiving said first signal and for automatically actuating said drain means in response to said first signal.

28. The improved fuel processor according to claim 27, wherein said chamber probe means is further adapted for detecting the presence of a level of said water or other impurities lower than said predetermined level in said lower portion of said chamber and for generating a second signal to indicate the presence of said lower level, said automatic control means further being adapted to automatically deactuate said drain means in response to said second signal, whereby the quantity of water or other impurities within said chamber is automatically maintained generally between said predetermined quantity and a lesser quantity corresponding to said lower level.

29. The improved fuel processor according to claim 27, wherein said chamber probe means comprises at least one elongated probe protruding in a generally upwardly direction into the lower portion of the chamber, said probe being adapted to generate distinct signals when exposed at various points along its length to one or more fluids having distinct electrical characteristics, said automatic control means being adapted to differentiate between said distinct signals in order to actuate and deactuate said drain means in response to said first and second signals, respectively.

30. The improved fuel processor according to claim 29, wherein said drain means includes a solenoid-operated valve adapted to provide communication therethrough between the interior of said lower portion of said chamber and the exterior of said fuel processor means to discharge said substantial portion of said water or other impurities when said solenoid-operated valve is actuated, said solenoid-operated valve further being adapted to prevent said communication when said solenoid-operated valve is deactuated.

31. The improved fuel processor according to claim 20, wherein said drain means further includes pumping means operatively connected to said solenoid-operated valve, said pumping means being actuated and deactuated by said control means in conjunction with respective actuation and deactuation of said solenoid-operated valve.

32. The improved fuel processor according to claim 30, wherein said chamber probe means comprises a pair of said elongated probes protruding generally upwardly into the lower portion of the chamber, said chamber probes being separated but located closely adjacent to one another relative to the distance from said probes to the wall of the chamber and being adapted to generate distinct signals when

exposed at various corresponding levels along each of their lengths to one or more fluids which have distinct electrical characteristics and extend between said chamber probes.

33. The improved fuel processor according to claim 13, further comprising chamber temperature sensing means located in the lower portion of the chamber and adapted to generate a low temperature signal in response to detection of temperature below a predetermined temperature level in the lower portion of the chamber, said control means being adapted to receive said low temperature signal and to automatically prevent actuation of said drain means in response thereto.

34. A fuel processing system operative to separate out water from said fuel, said fuel processing system conducting said fuel from a fuel tank, and returning said fuel to said fuel tank, said system comprising:

a fluid-tight chamber having a fuel inlet and a fuel outlet, said fuel and said water being substantially separated in a lower portion of said chamber;

drain means actuable to discharge a substantial portion of said water or other impurities from said chamber;

an inlet conduit conducting said fuel from said fuel tank to said chamber fuel inlet;

an outlet conduit conducting said fuel from said chamber fuel outlet; and

pump means interconnected to one of said conduits.

35. The fuel processing system of claim 34 further comprising fuel tank quantity sensing means located in said fuel tank for detecting the presence of at least one predetermined quantity of said water, and control means actuable to cause said pump means to cause said fuel to

flow within said chamber in response to the detection by said fuel tank sensing means of said predetermined quantity of said water.

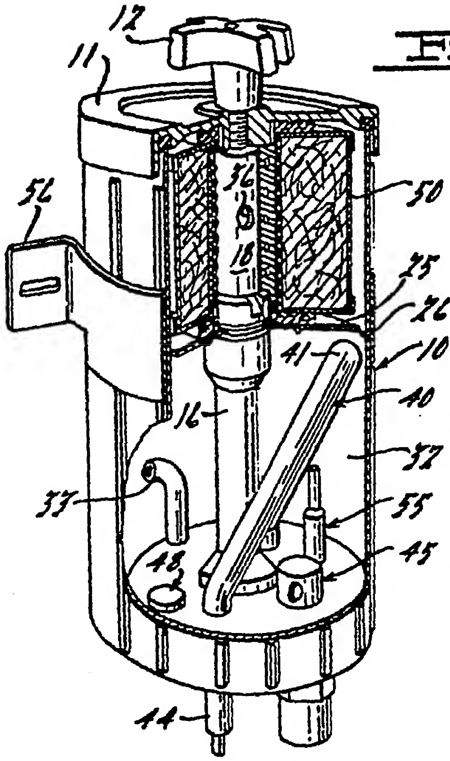
36. The fuel processing system of claim 35 further comprising fuel tank temperature sensing means located within said fuel tank, said fuel tank temperature sensing means providing a signal to said pump means to cause said pump means to cause said fuel to flow within said chamber in response to a sensed temperature above a predetermined temperature level thereby preventing improper operation of said pump resulting from ice being introduced therein.

37. The fuel processing system of claim 34 wherein said pump means is interconnected to said inlet conduit and said drain means comprises a solenoid-operated valve.

38. The fuel processing system of claim 34 wherein said pump means is interconnected to said outlet conduit and said drain means comprises a pump.

39. The fuel processing system of claim 38 wherein said pump is a positive displacement type.

FIG. 1.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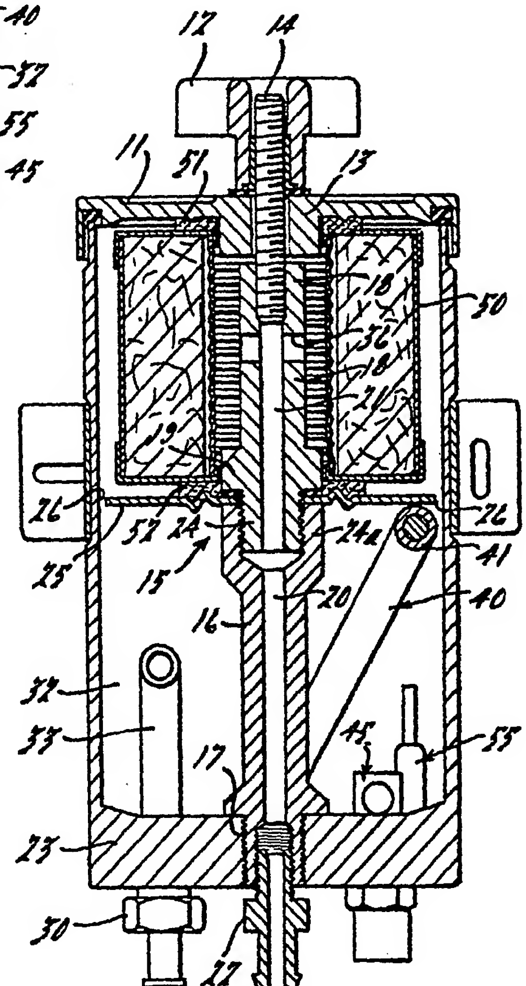
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FIG. 2.

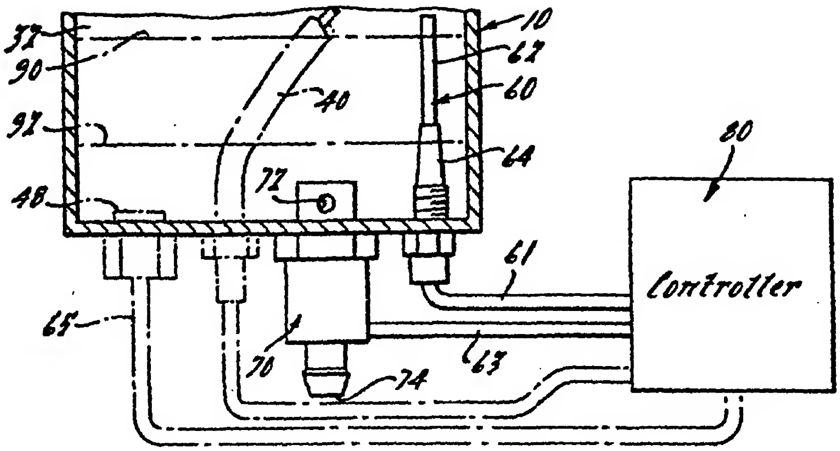

FIG. 3.

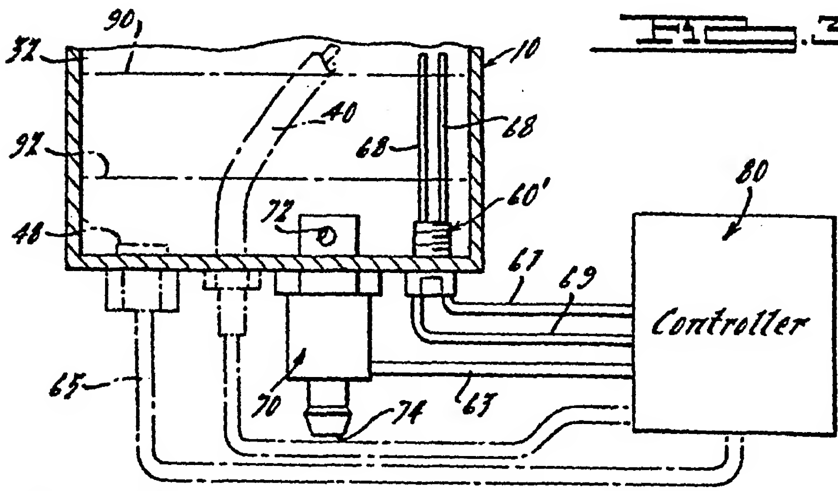

FIG. 4.

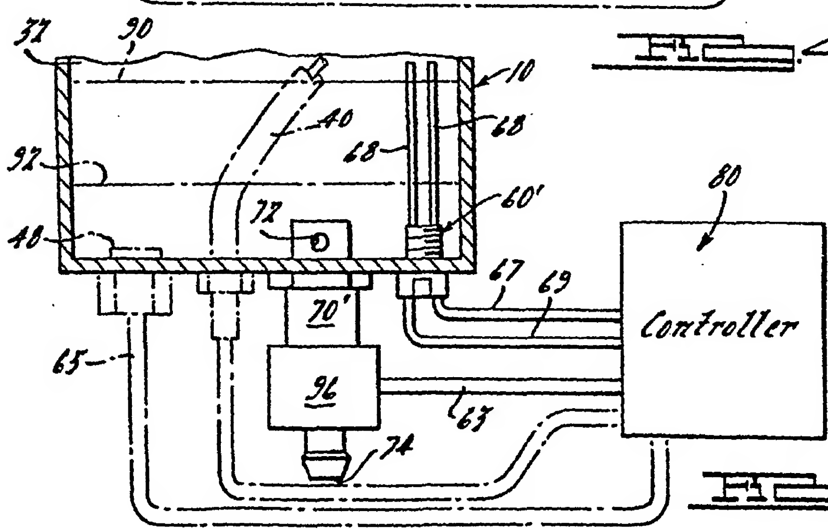

FIG. 5

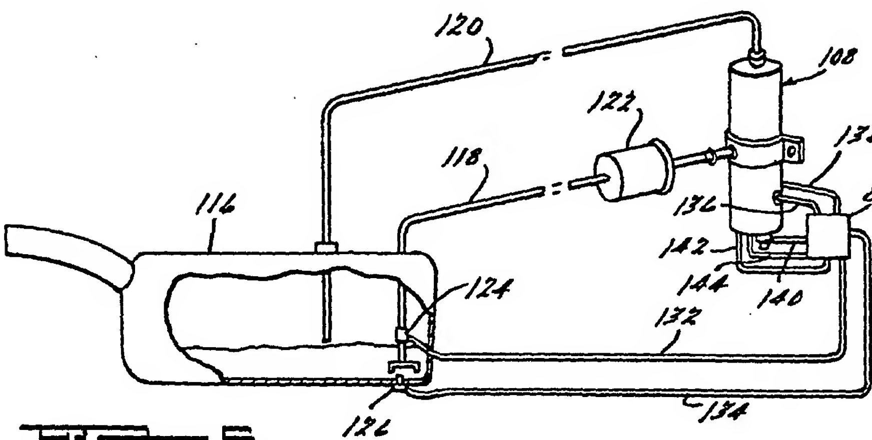
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FIG.6.

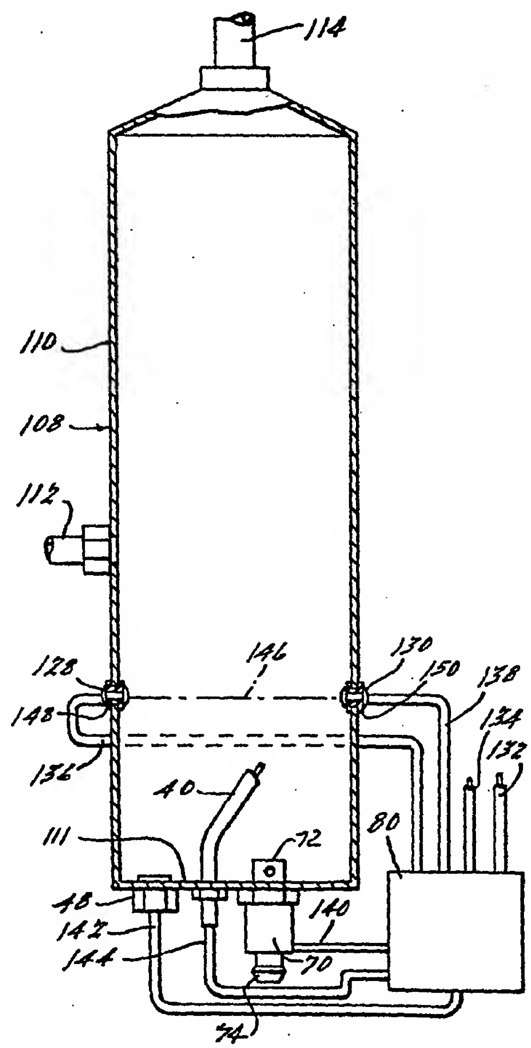
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FIG.7.